



# Trends and Projections of Sea Level Rise in Miami

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UNIVERSITY OF MIAMI

ROSENSTIEL  
SCHOOL of MARINE &  
ATMOSPHERIC SCIENCE



# Hurricane Irma

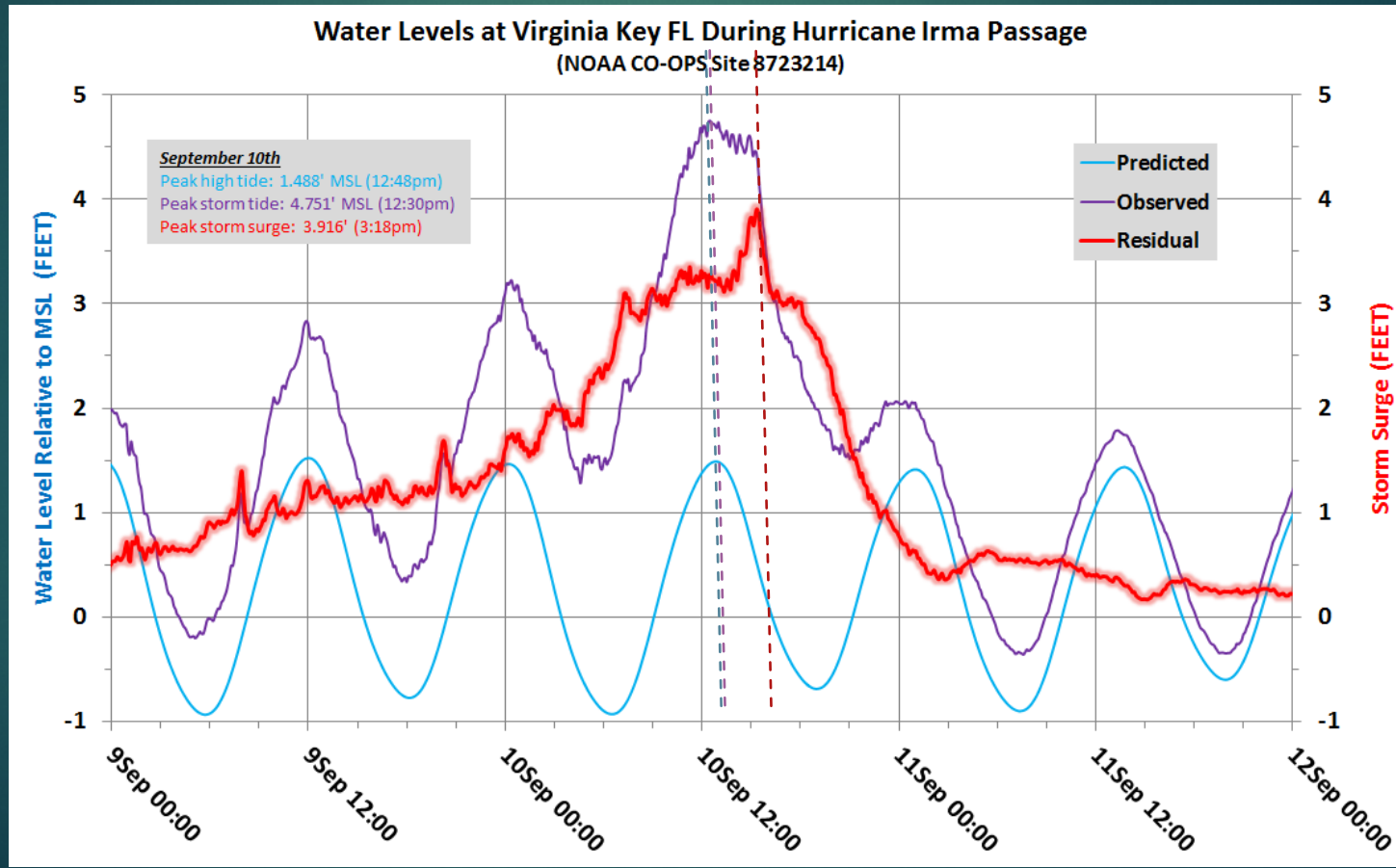
- ▶ Center of large and slow-moving storm passed 95 miles west of us, brought upper-end TS to low-end Category 1 hurricane conditions to the area

<embedded radar loop>  
available at

[http://andrew.rsmas.miami.edu/bmcnoldy/tropics/irma17/Irma\\_9-10Sep17\\_KAMX.gif](http://andrew.rsmas.miami.edu/bmcnoldy/tropics/irma17/Irma_9-10Sep17_KAMX.gif)

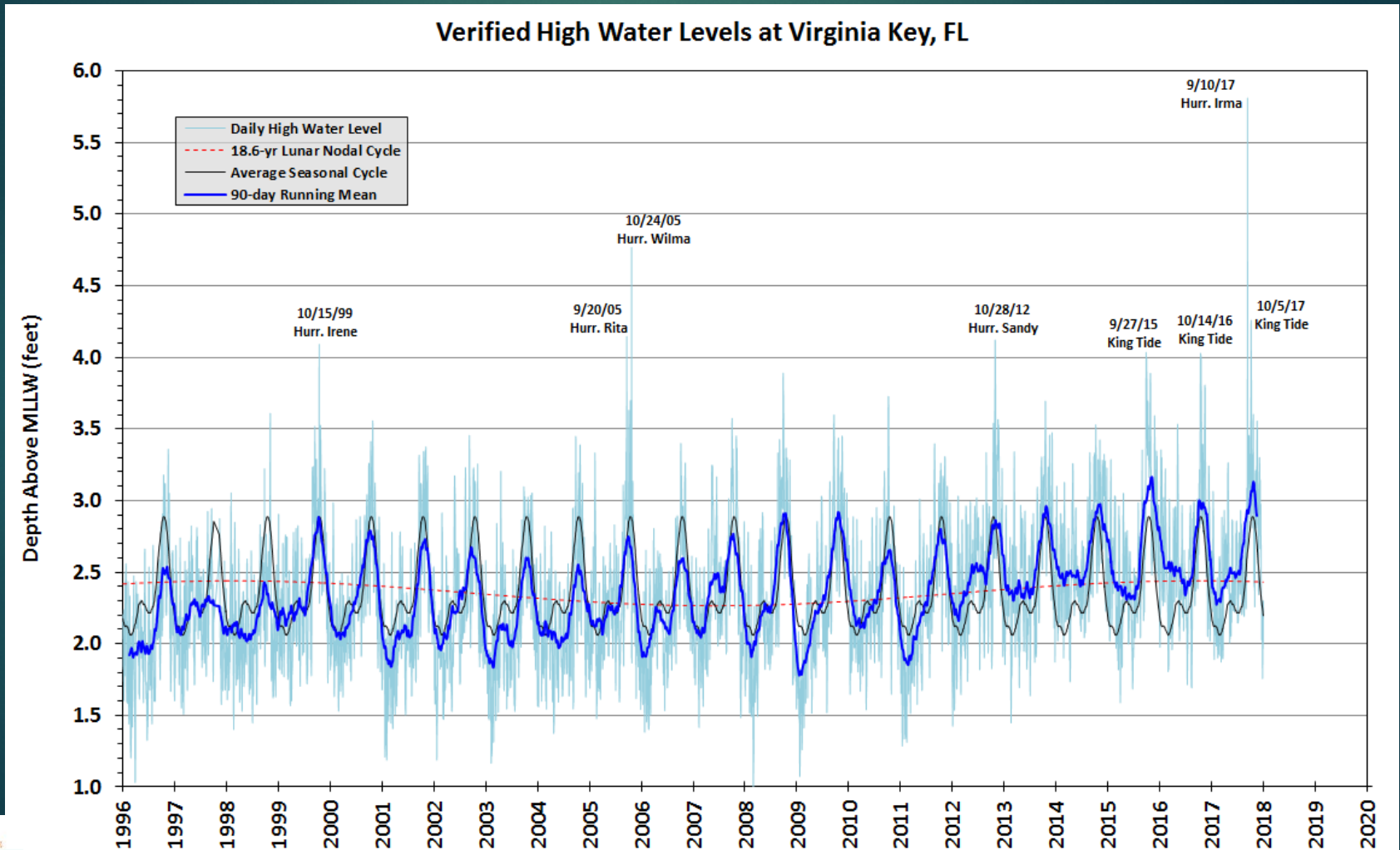
# Hurricane Irma

- ▶ Irma brought highest water level observed to the UM Rosenstiel campus on afternoon of Sep 10, 2017... ~13 inches higher than during Hurricane Wilma (Storm SURGE was less, but storm TIDE was higher)



# 22+ Years of Tide Gauge Measurements

- ▶ Highest water levels used to be associated only with hurricanes... King Tides can be comparable now



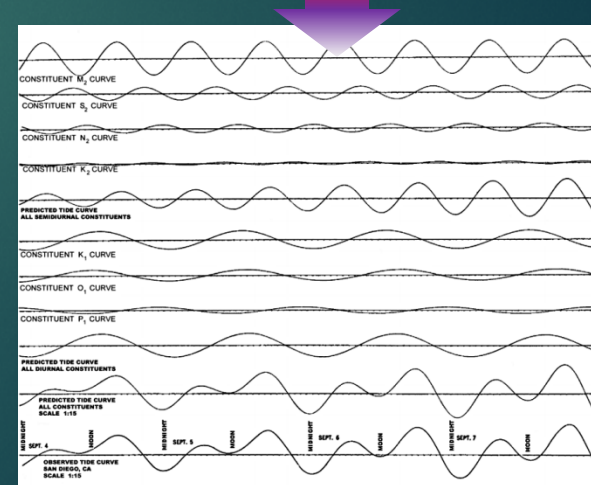
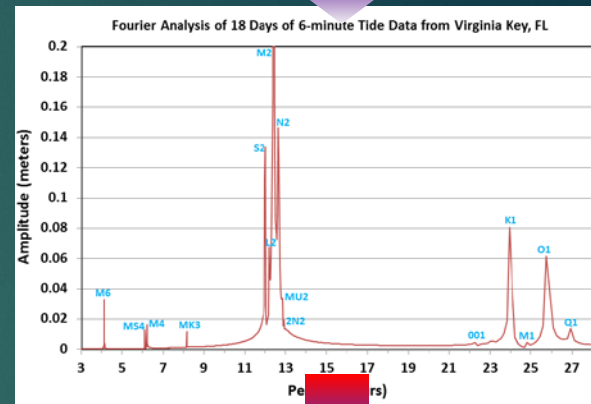
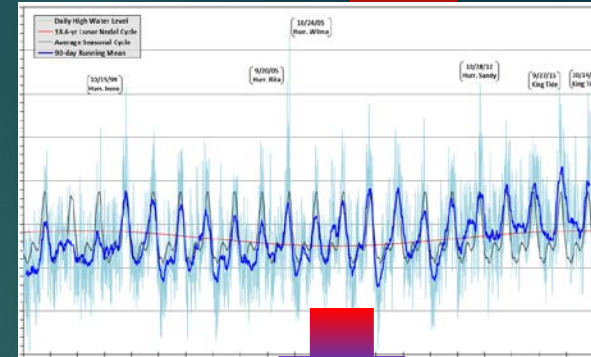
# What Tide Predictions Are... and Are Not

- ▶ Tide predictions rely on a long time series of actual tide observations at a location... then conduct Fourier decomposition
- ▶ A list of sinusoidal components is the result, each with a phase, frequency, and amplitude
  - ▶ The vast majority are driven by the moon and sun, but a couple may represent a crude climatology to approximate a seasonal cycle if one exists in the analysis
  - ▶ These components are added together to arrive at the total water level relative to a datum of choice:

$$h(t) = H_0 + \sum_{i=1}^n f_i H_i \cos[a_i t + (V_0 + u)_i - \kappa_i]$$

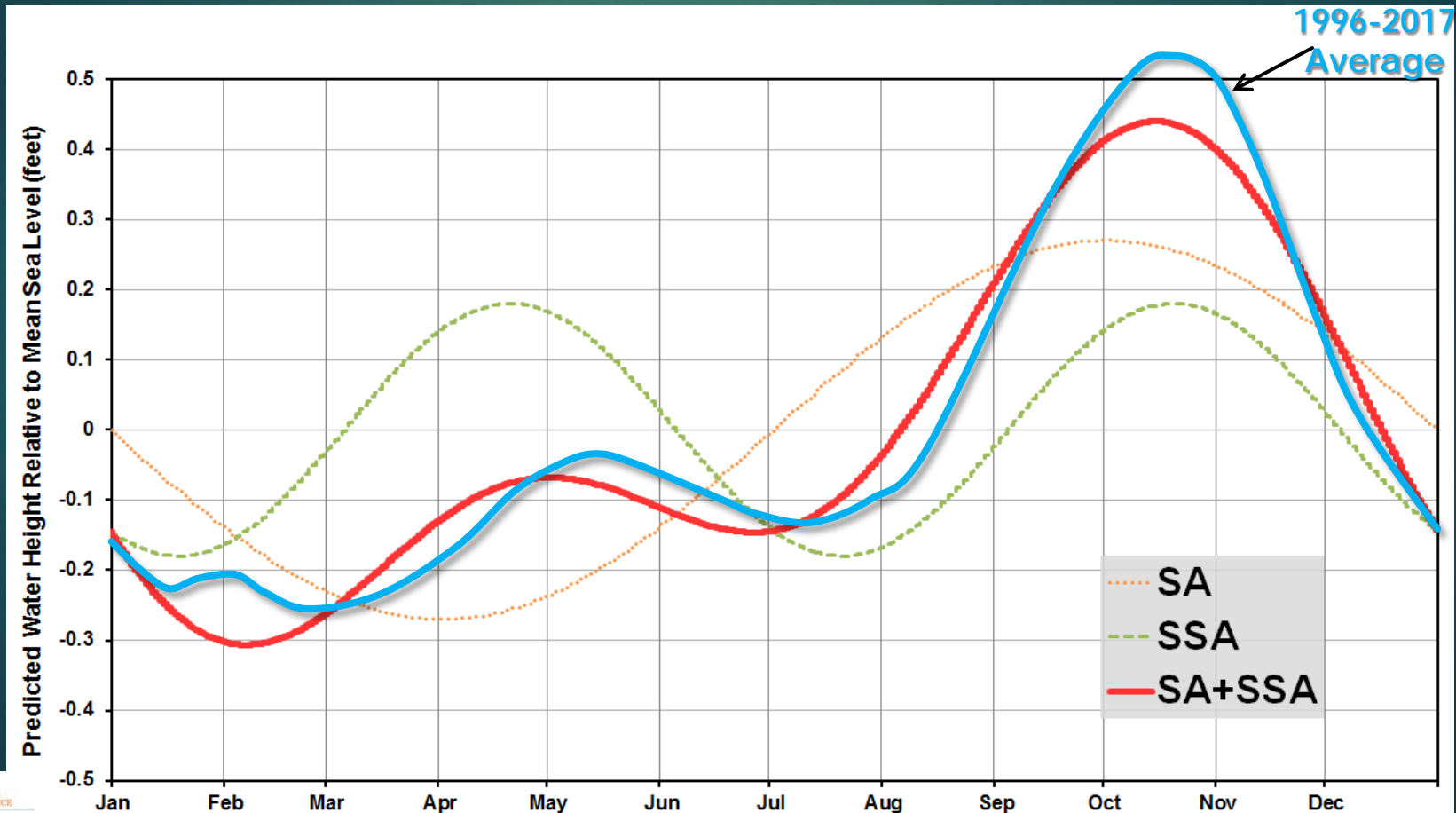
[The higher  $n$  is, the more accurately the time series can be reproduced]

- ▶ This can be done for years in advance, and has no dependence on the actual daily, weekly, or monthly weather/ocean conditions
- ▶ Tide predictions are not like weather predictions... they make no attempt to be actual custom predictions, but they are typically remarkably accurate!



# Southeast Florida Seasonal Cycle

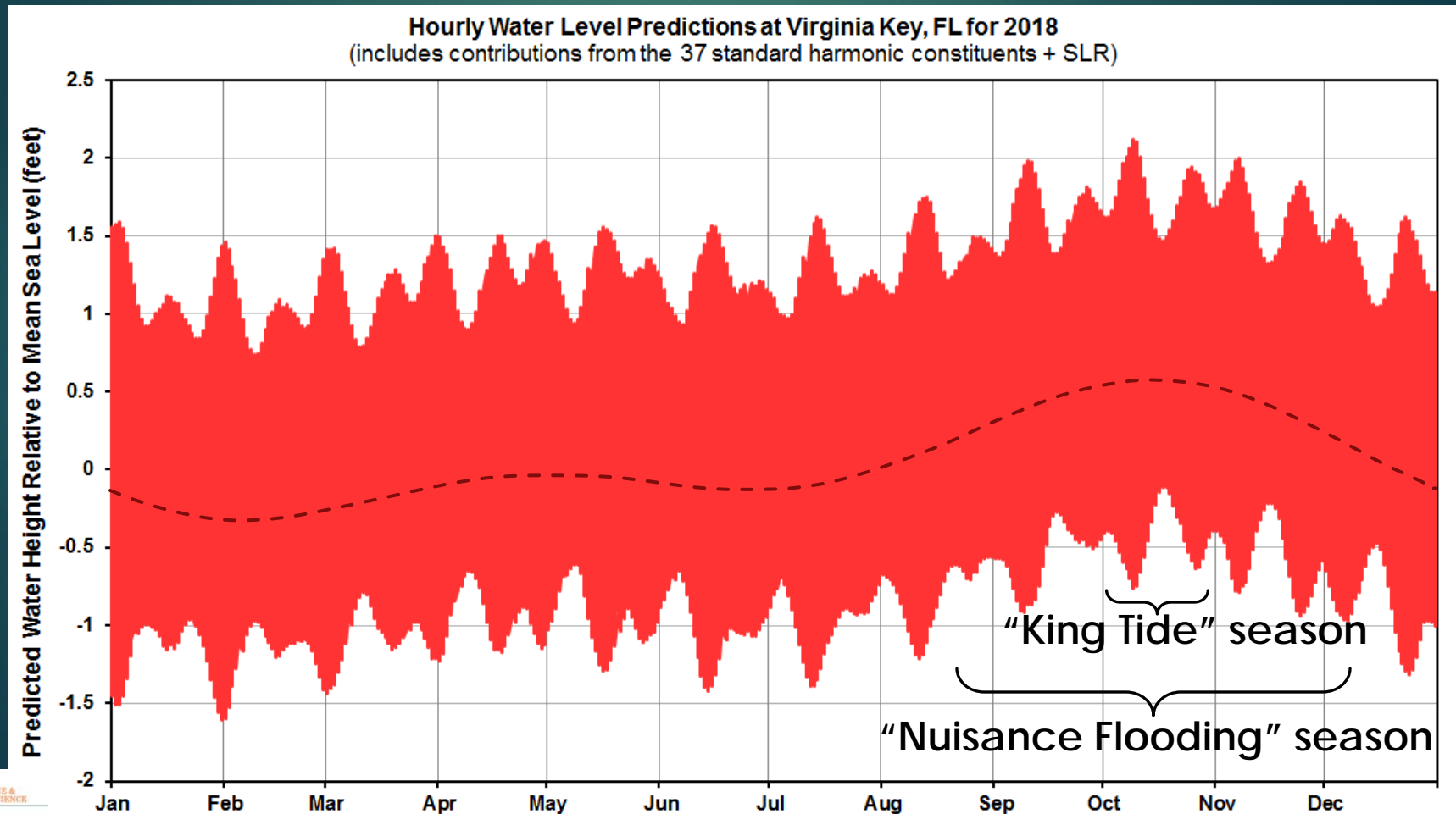
► In our area, the harmonic constituents called "SA" and "SSA" are combined to recreate the influence of a crude weather/ocean climatology... not astronomical in nature... the shape does match the observed climatology very well



~9"

# 2018 Tide Predictions for Southeast Florida

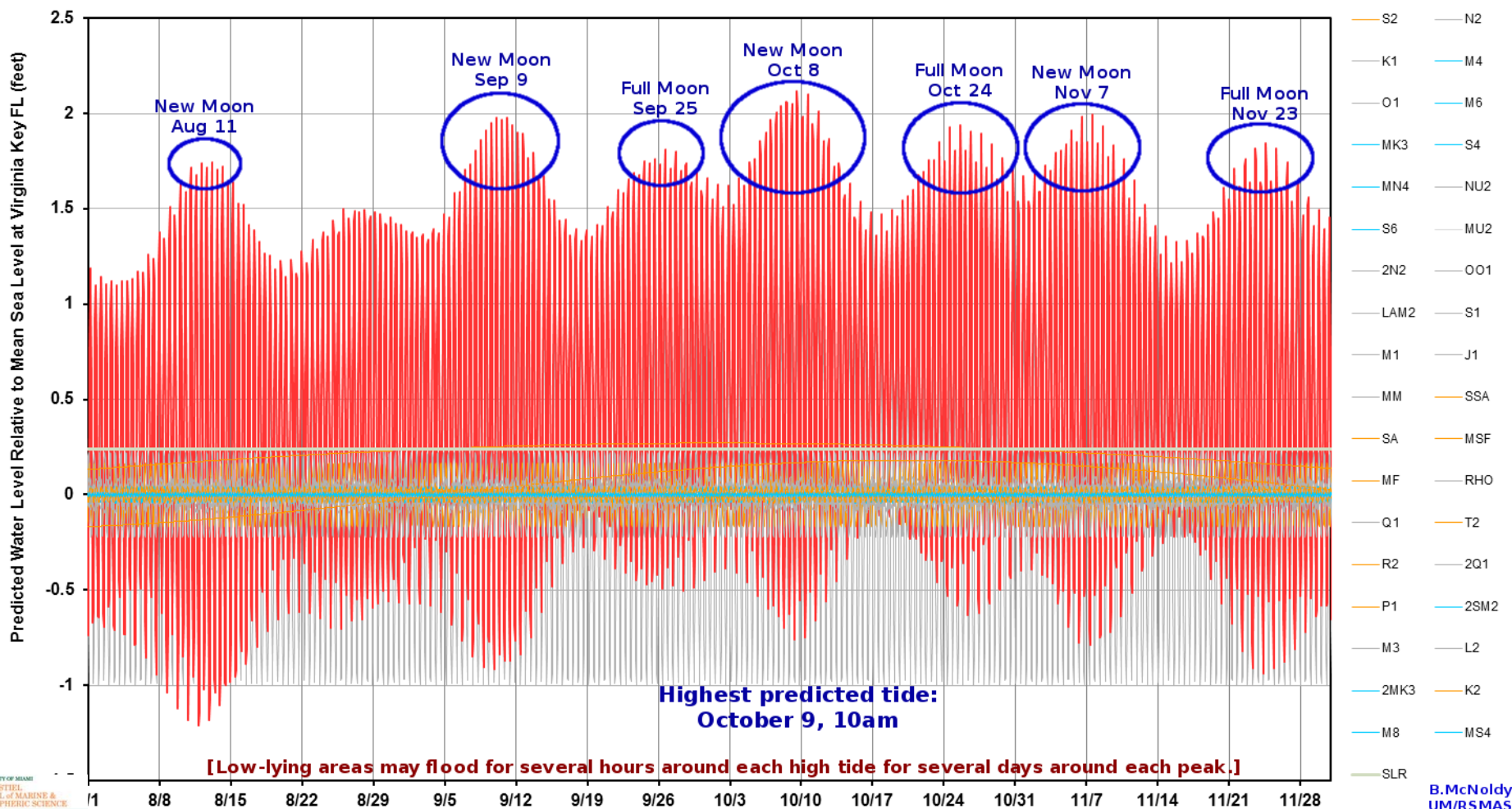
- ▶ Water level shown relative to the 1983-2001 epoch mean sea level at this location
- ▶ Mean seasonal cycle peaks on Oct 15... highest predicted tide of the year will typically occur near the full or new moon closest to that date



# 2018 Tide Predictions for Southeast Florida

► Zooming in on Aug-Nov and showing the various constituents...

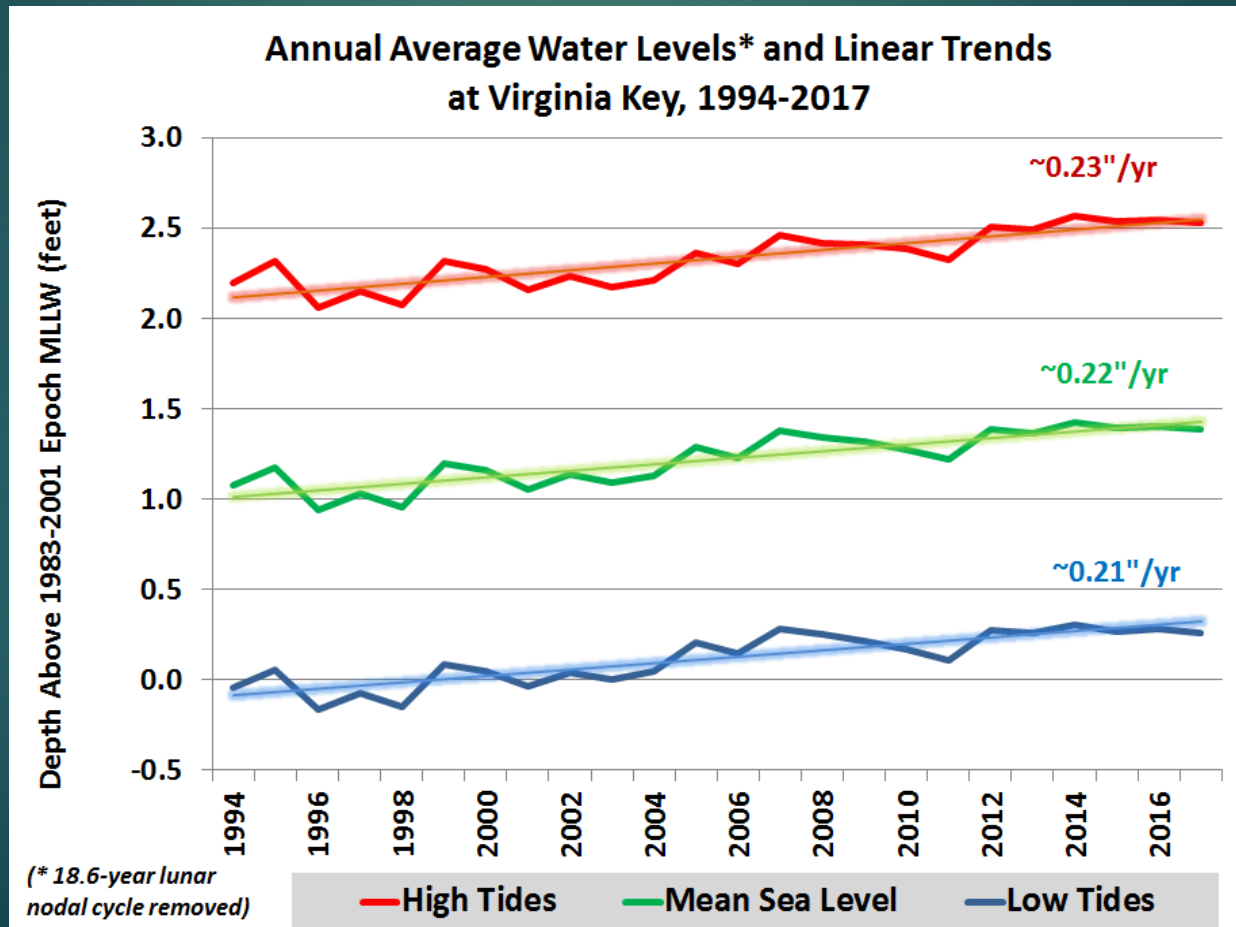
**Hourly Water Level Predictions at Virginia Key, FL for 2018**  
(includes contributions from the standard 37 harmonic constituents + SLR)





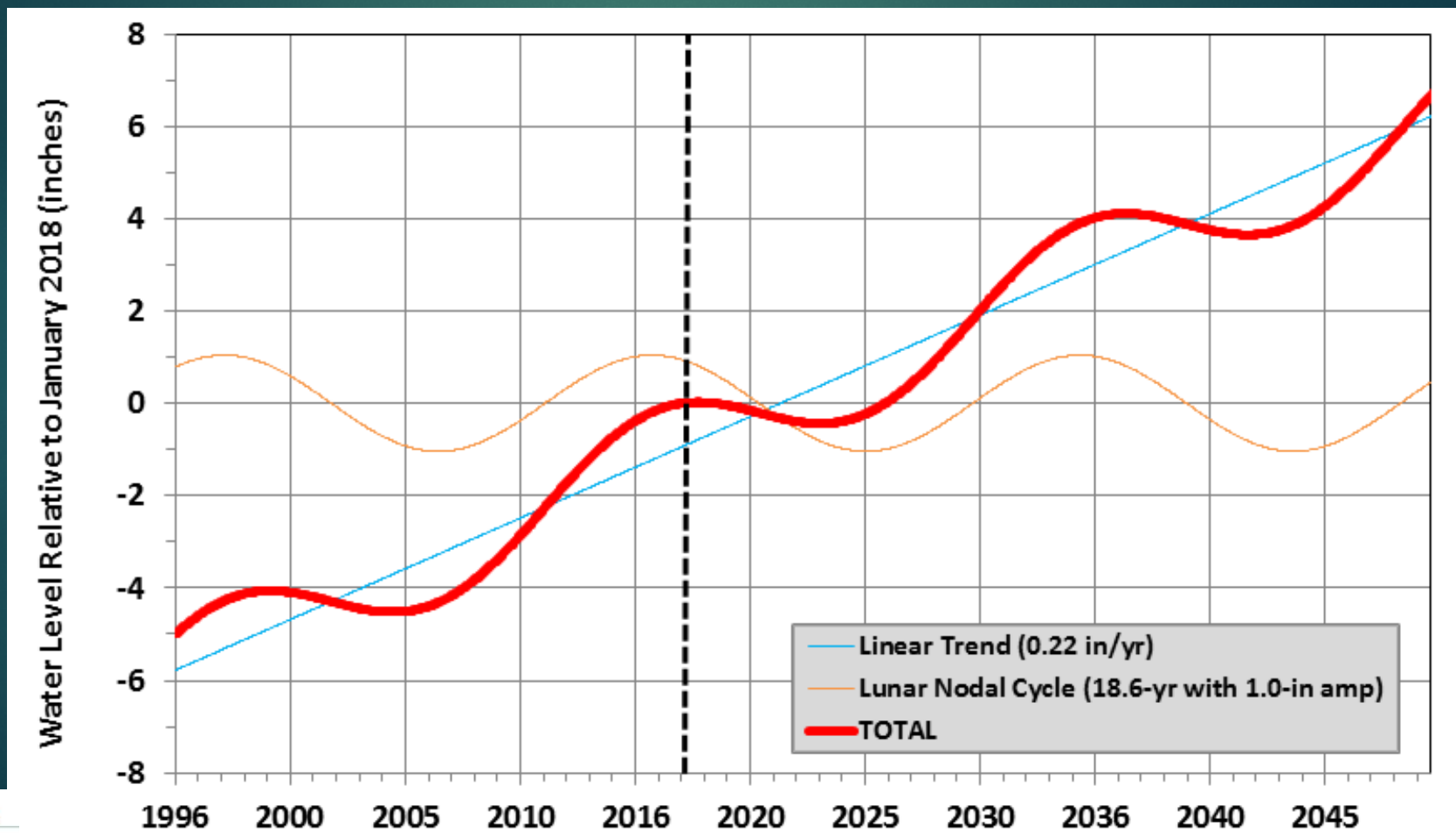
# Trends in Local Sea Level Rise

- ▶ There is interannual variability, but the upward trend is undisputable.



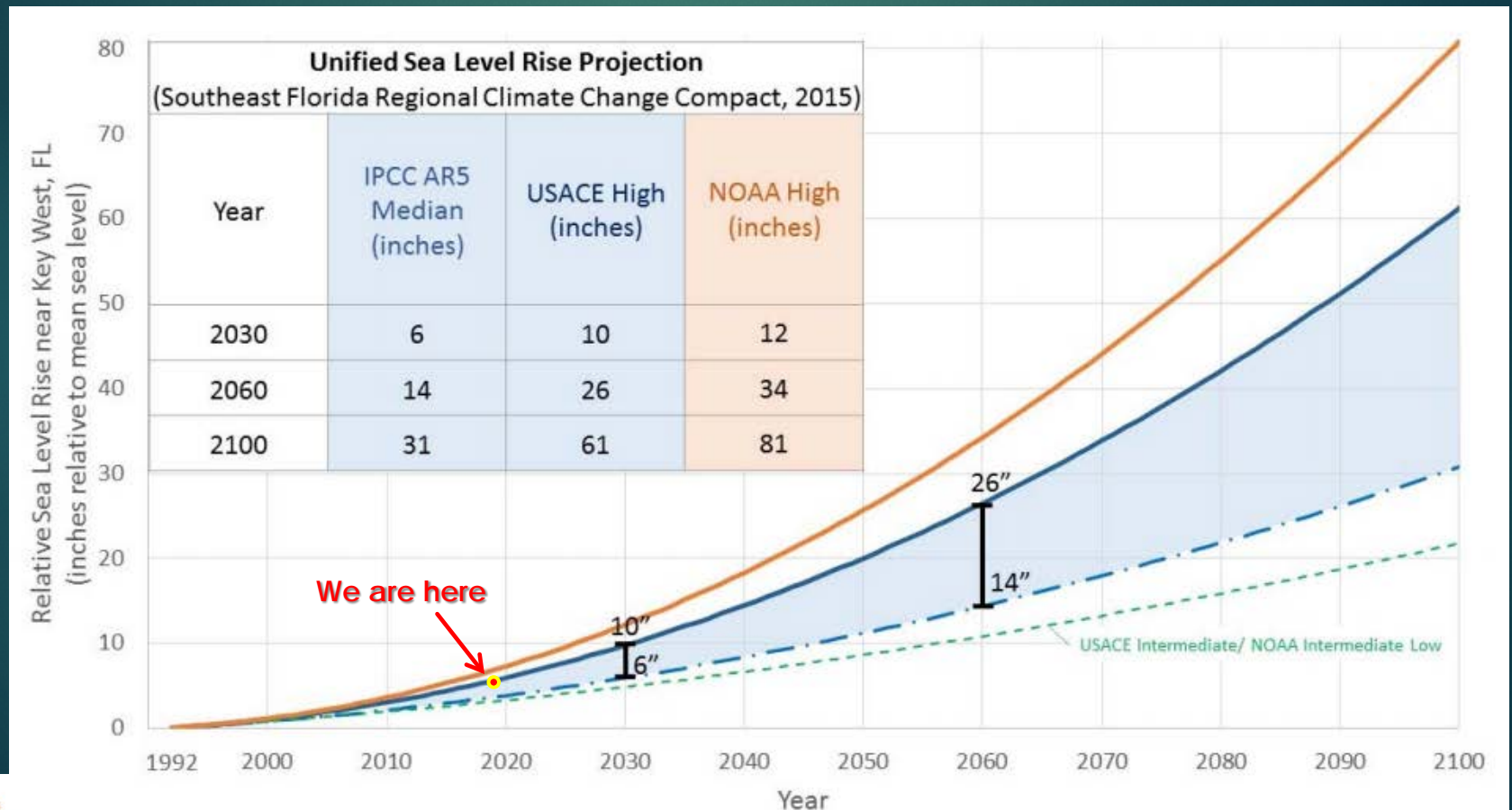
# Lunar Nodal Cycle

- ▶ The 18.6-year LNC affects apparent SLR...



# Projections for the Coming Decades

- Uncertainty increases with time... lots of unknowns, but all projections show an acceleration of SLR



# Florida is Flat!

- ▶ Changes in sea level over glacial timescales have a tremendous impact on the Florida peninsula...

